Assessing the Impact of Climate Change on the UK's Wave Energy Resource

Assessing the Impact of Climate Change on the UK's Wave Energy Resource

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Aim

- To project the wave climate around the UK for the 21st century for high, medium and low emissions scenarios and investigate the existence of a **causal link** with atmospheric greenhouse gas concentrations

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Methodology

- Using a calibrated wave model for the North Atlantic and UK, simulate current and projected wave climate (height, energy period and direction) for the high, medium and low GHG emissions scenarios
- Establish the capability of Wavewatch III v4.18 model through:
  - Validation of contemporary climate against observations
  - Comparison of spatial trends between projections and contemporary climate
- Assess the magnitude of changes in absolute and relative terms
- Investigate the existence of a causal link between the wave climate changes and GHG levels using the Analysis of Variance (ANOVA) method

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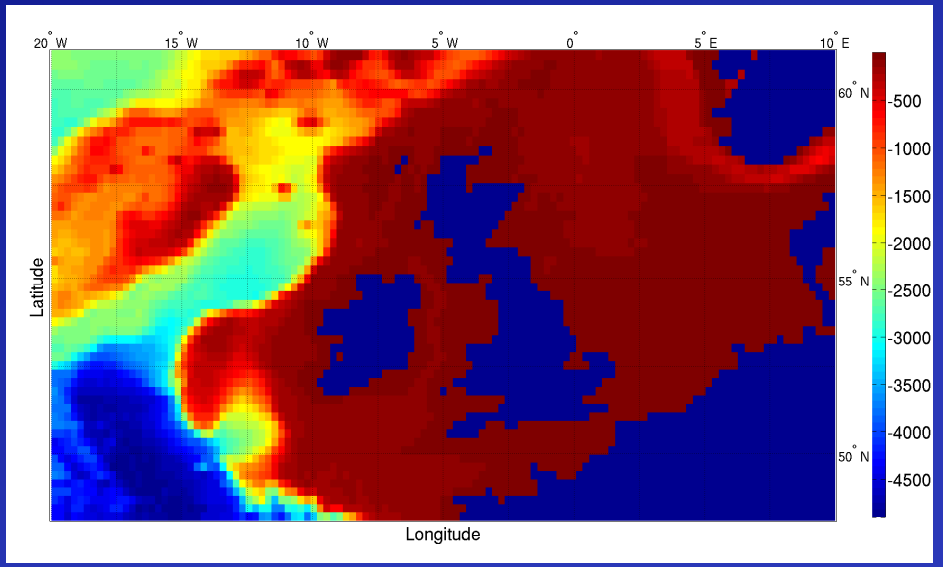
Datasets and Modelling

- Wave data simulated using WAVEWATCH III v 4.18
- Hourly gridded wave data at 0.25°x0.25° spatial resolution
- Tuning parameter values obtained from response surface optimisation were used
- NCEP 20th Century Reanalysis (20CR) wind data used for simulating the historical 'observed' wave climate
- ECHAM5 GCM wind data for climate change scenarios



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Calibration

- A Monte-Carlo type experiment was designed to calibrate the wave model, including:
- Experiment to tune the values of the wind growth term (β), swell attenuation factor (s) and the JONSWAP bottom friction coefficient (Γ)
- 500 trials designed using the Latin Hypercube sampling scheme to optimise computational effort and accuracy
- Response surfaces were generated to examine parameter effect on significant wave height (H_s) and peak wave period (T_p)
- Response surfaces were simultaneously optimised to minimise the bias between model and buoy measurements

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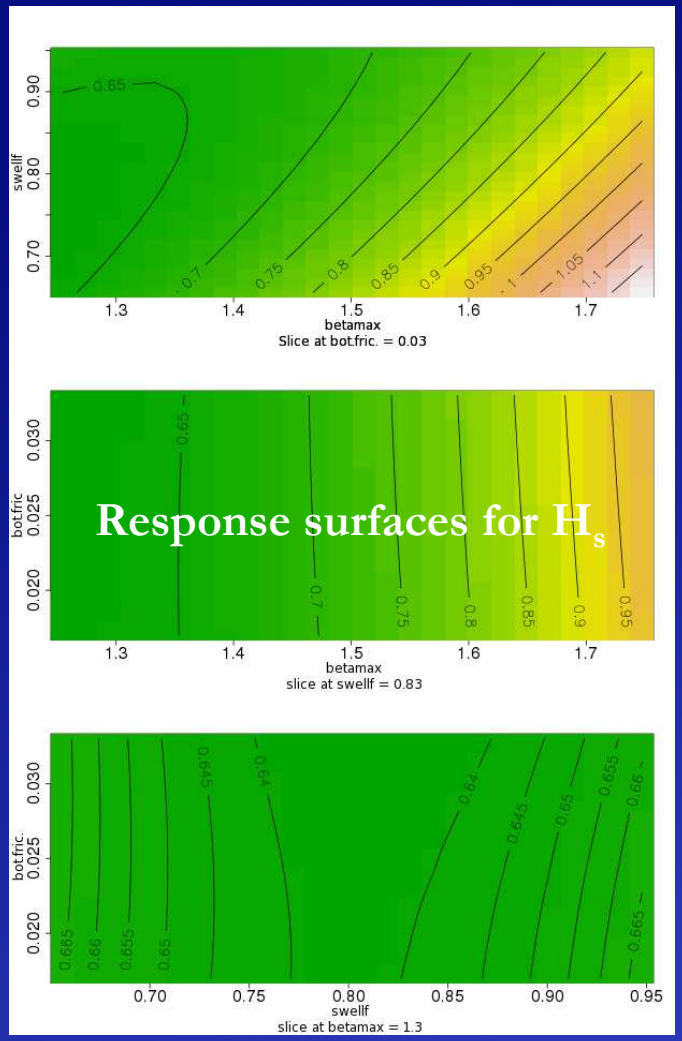
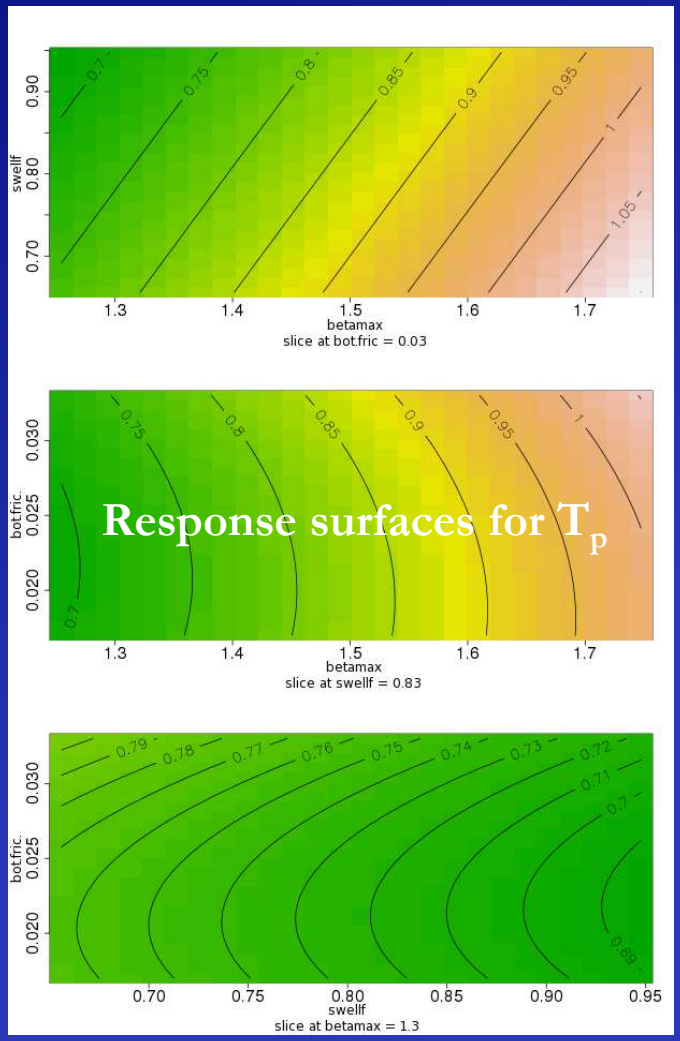
Calibration



Response surfaces for H_s



Response surfaces for T_p

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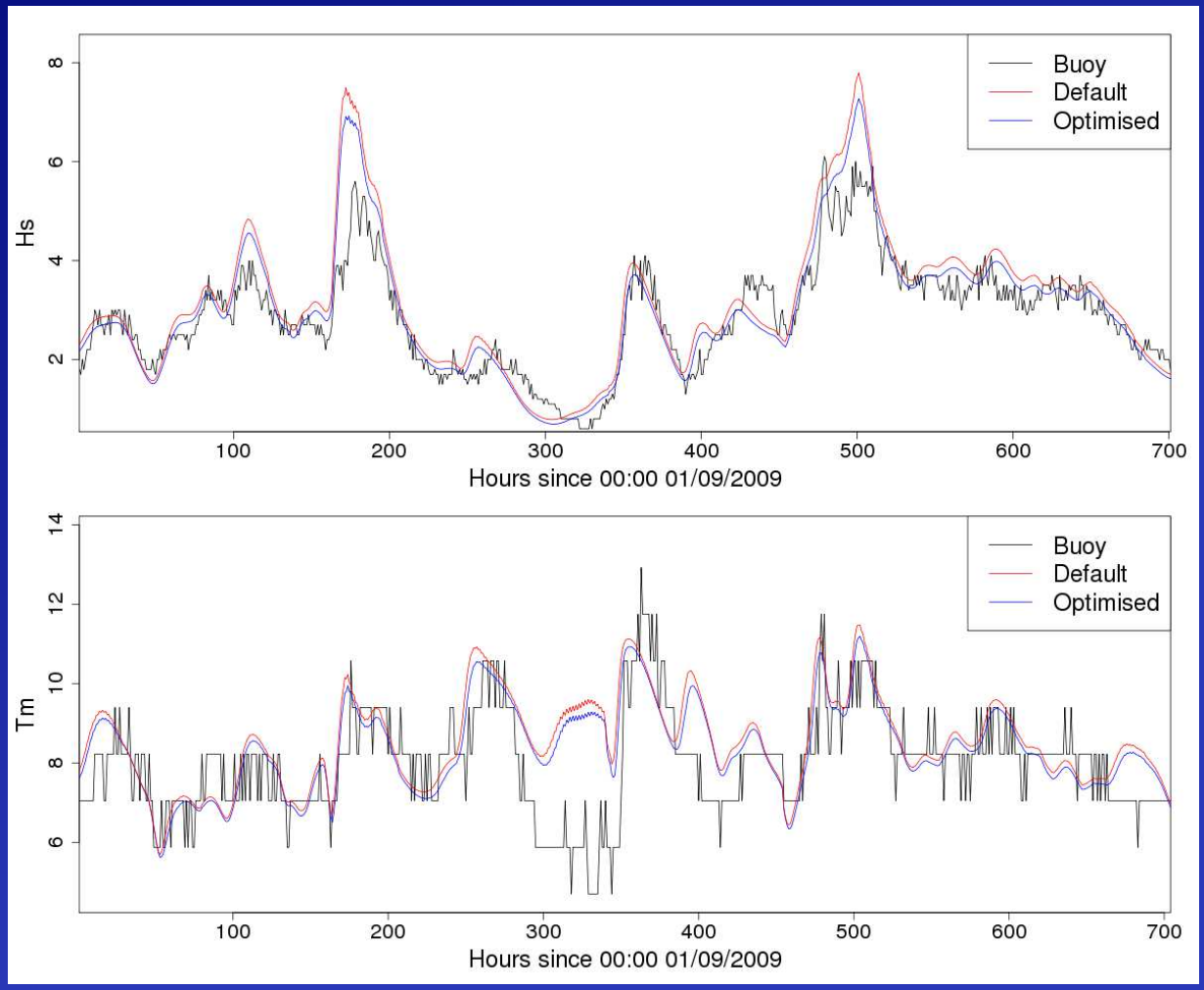
Validation

Comparison of wave model output for default and optimised parameter values compared with buoy observations for the location West of Hebrides



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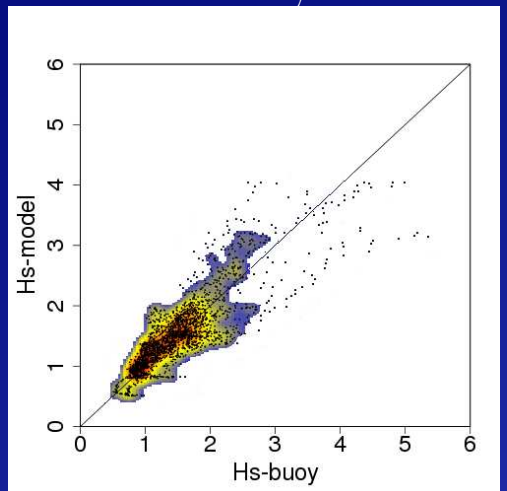
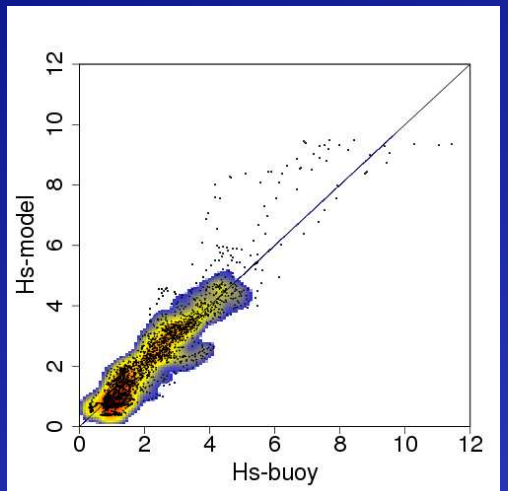
Validation

NDBC buoy 41048

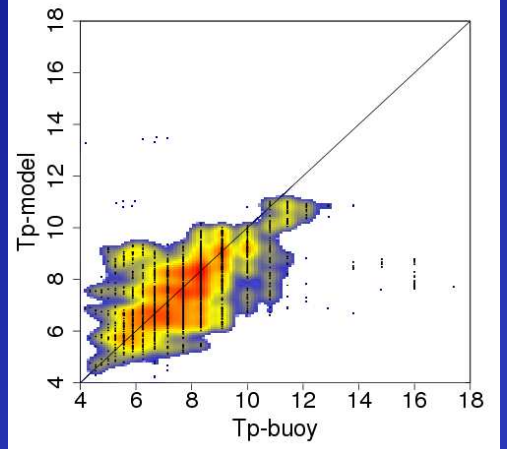
West of Hebrides

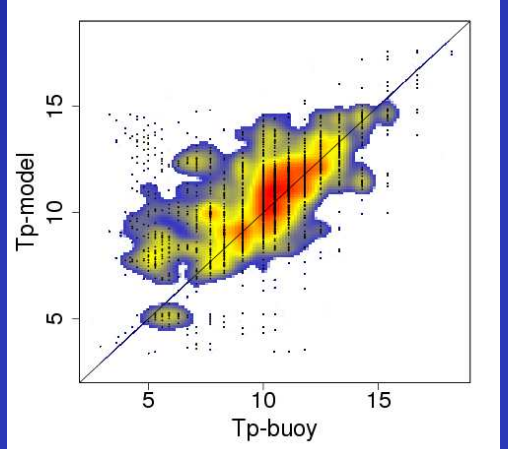
H_s





T_p





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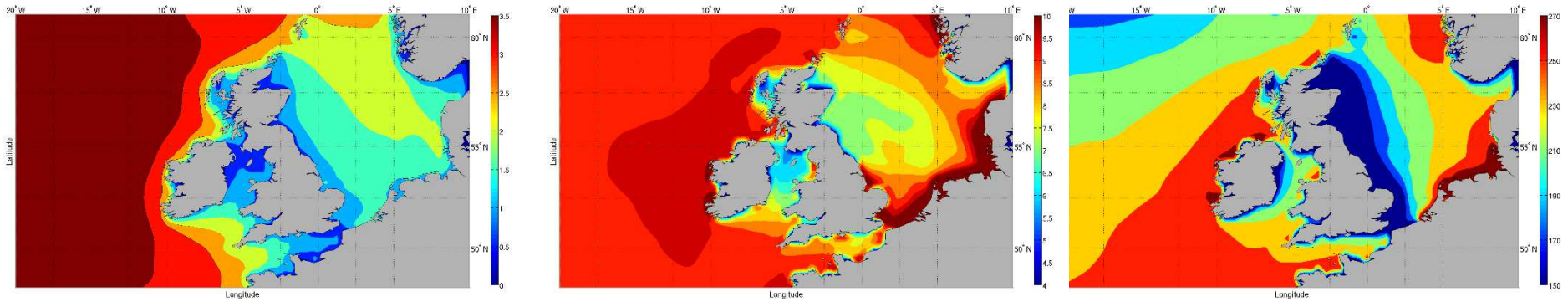
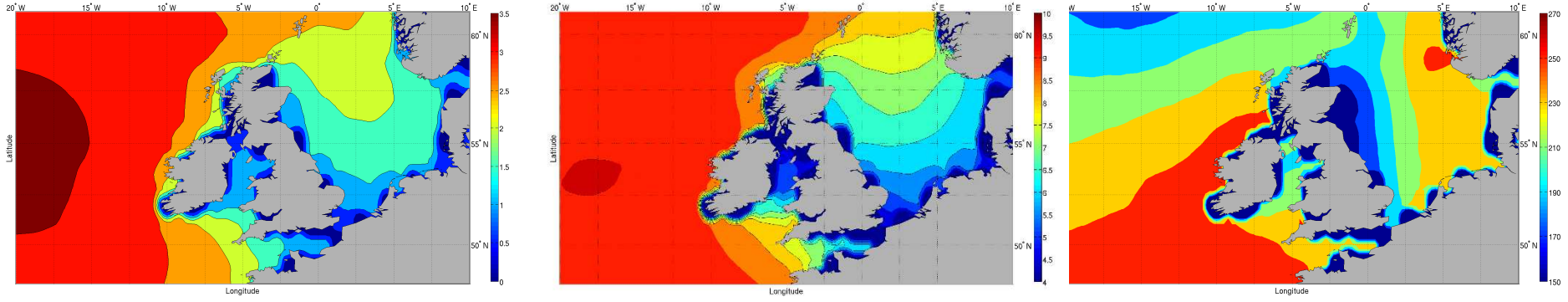
Validation: ERA-Int



Wave data from reanalysis winds (20CR)



Wave data from ECMWF ERA-I

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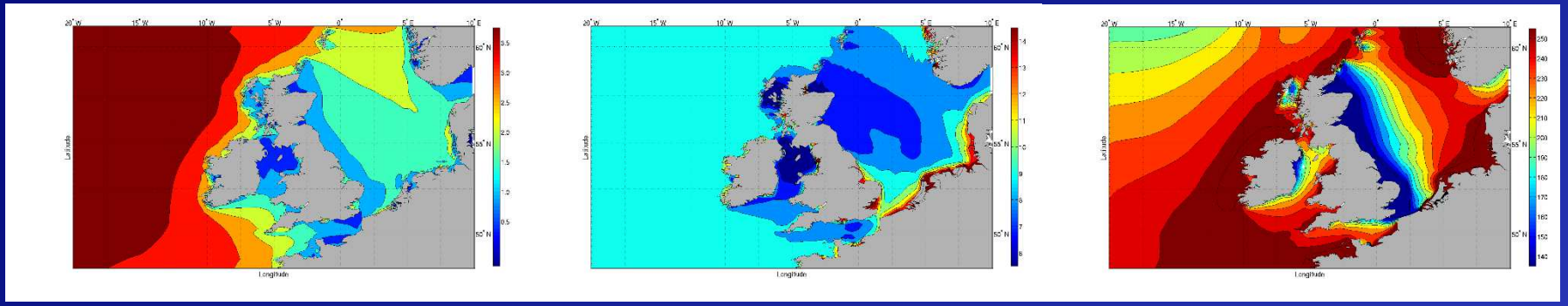
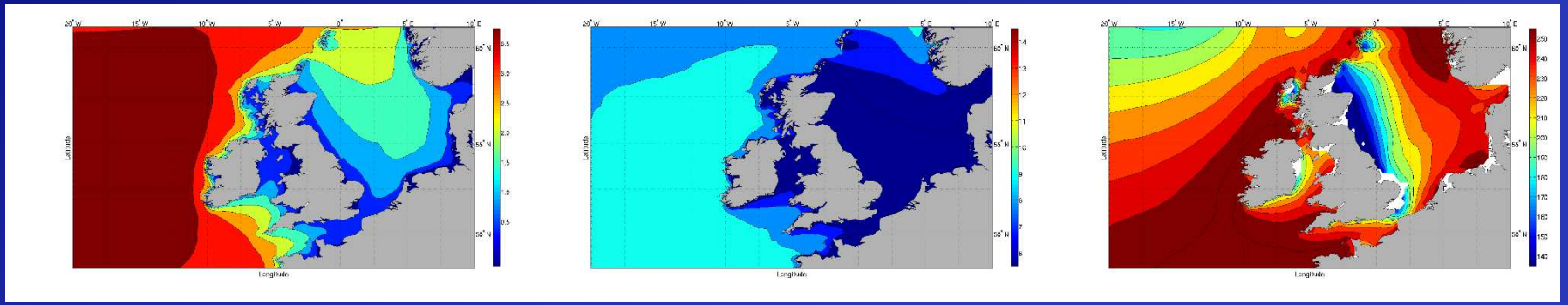
Comparison of Contemporary Climate



Wave data from reanalysis winds (20CR)



Wave data from GCM data for the A1B scenario

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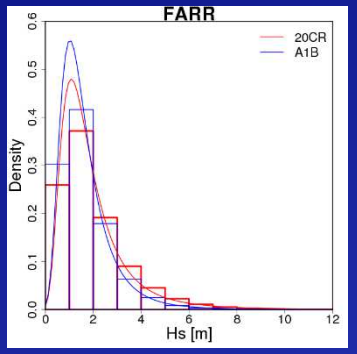
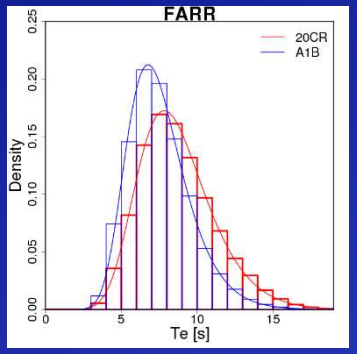
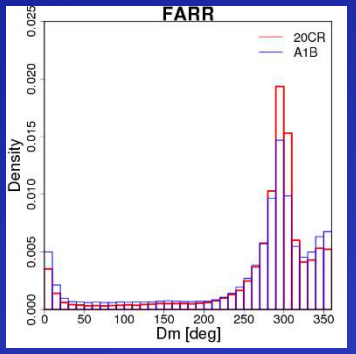
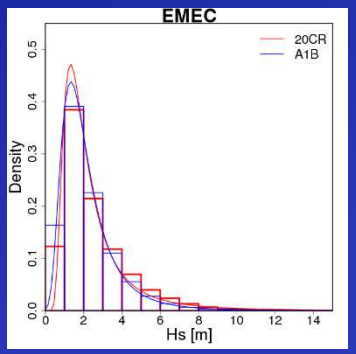
Comparison of Contemporary Climate

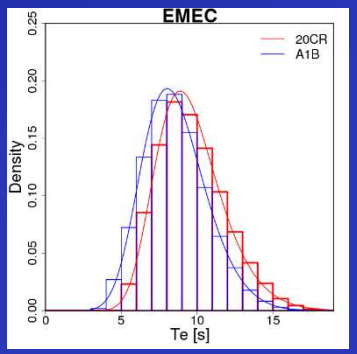
- Good agreement between H_s and D_m at site and regional levels
- Lower confidence in T_e on account of differences at the site and regional levels

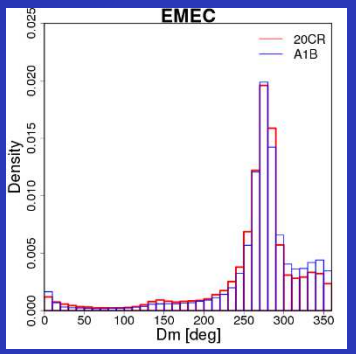












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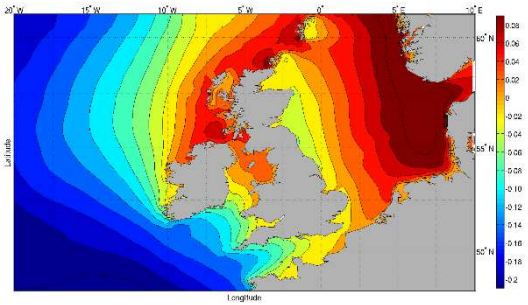
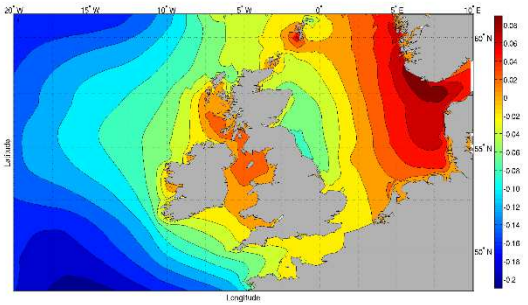
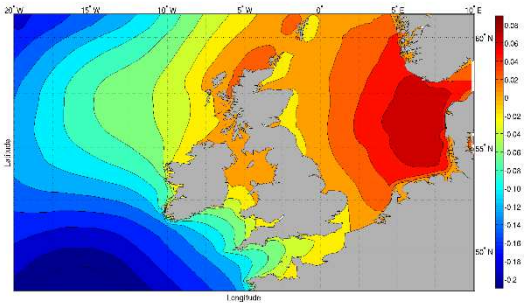
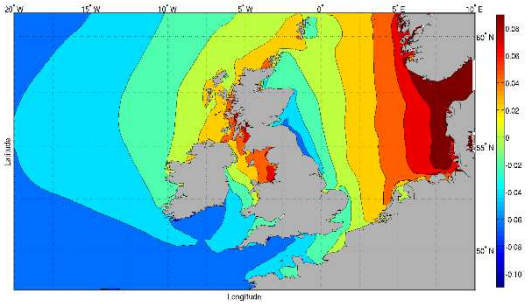
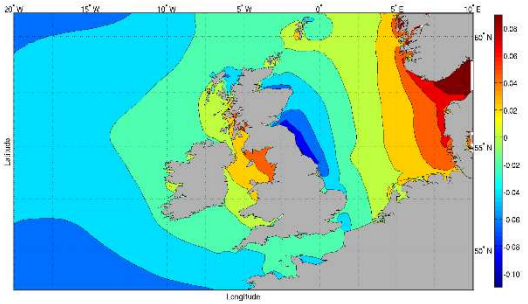
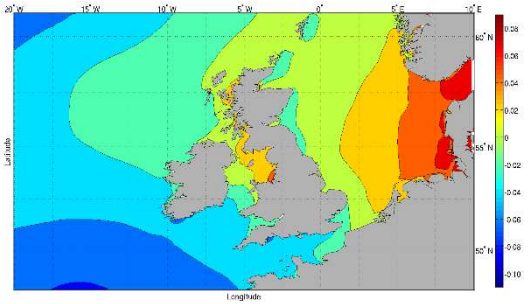
Changes in Wave Climate 2001 – 2100: H_s

	A2	A1B	B1
Absolute			
Relative			

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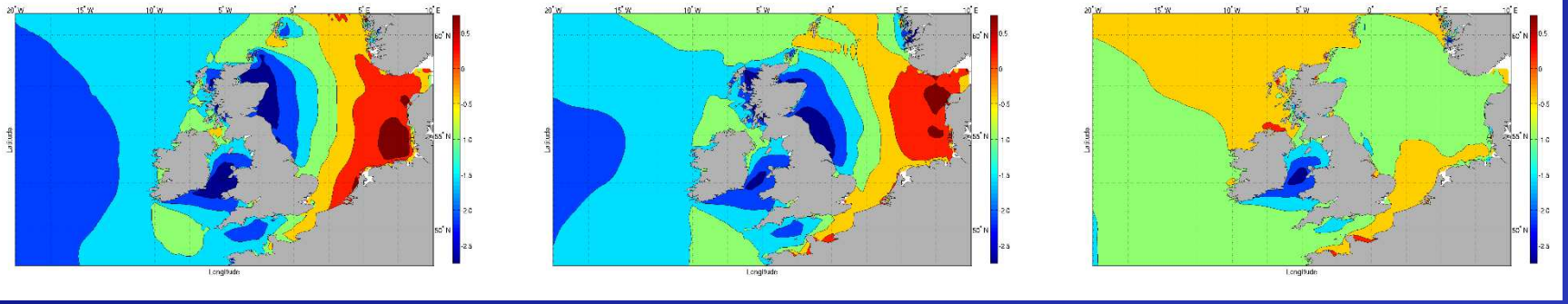
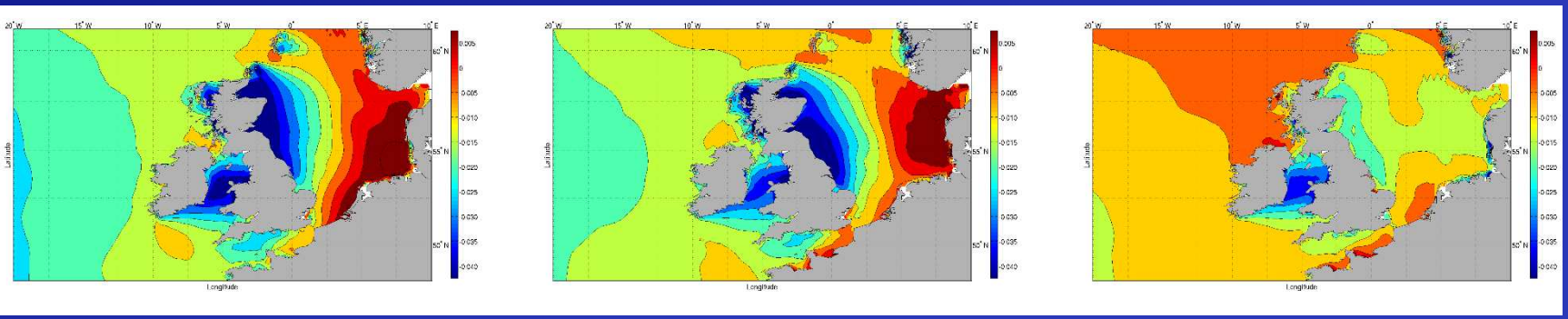
Changes in Wave Climate 2001 – 2100: T_e

A2 A1B B1

Absolute



Relative



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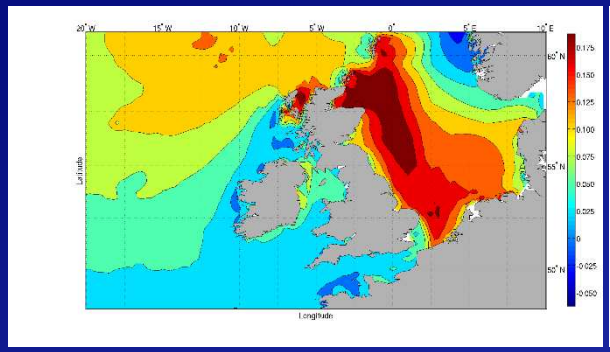
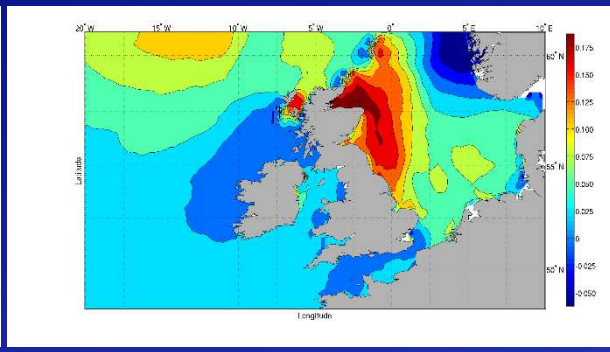
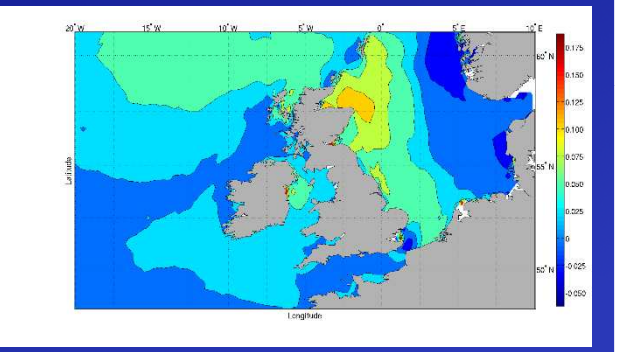
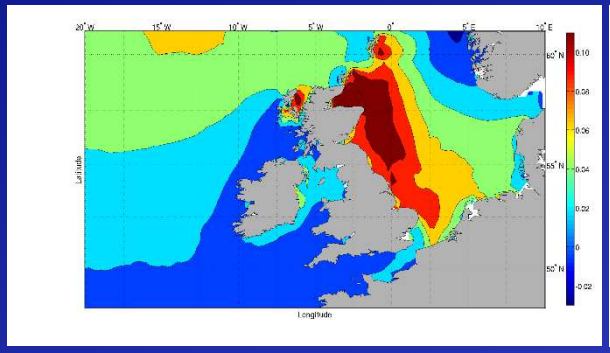
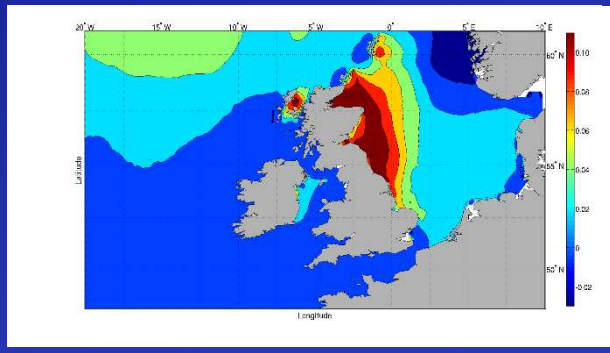
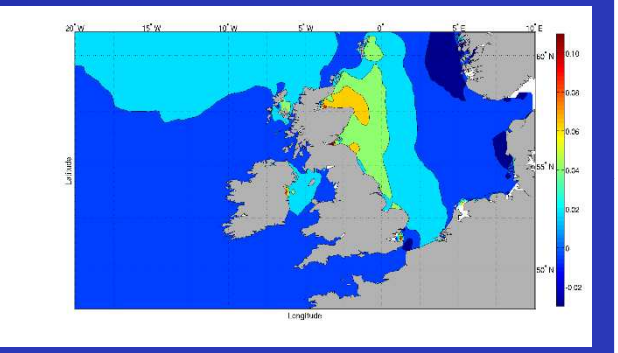
Changes in Wave Climate 2001 – 2100: D_m

	A2	A1B	B1
Absolute			
Relative			

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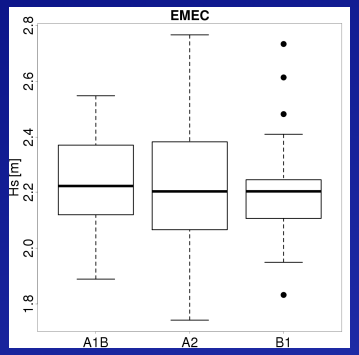
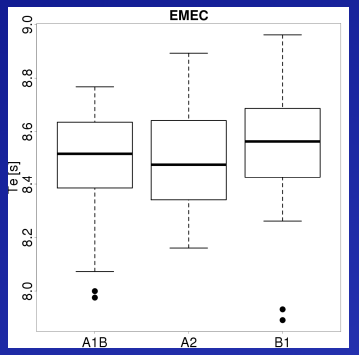
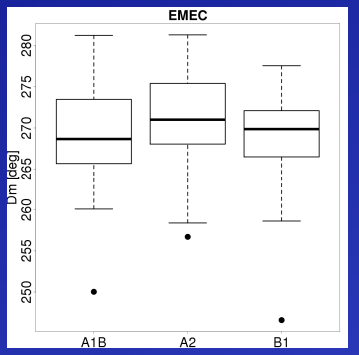
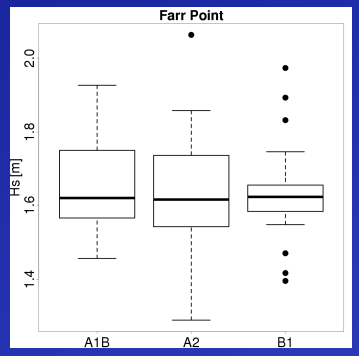
Analysis of variance

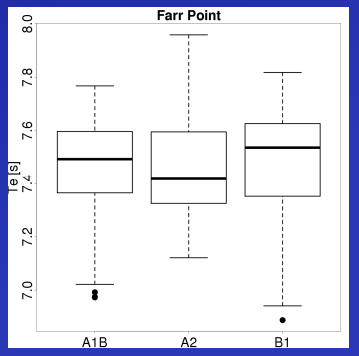
- ANOVA test applied to samples of wave data from 2071-2100 from the A2, A1B and B1 scenarios
- Results show no statistically significant differences between the samples
- Results indicate that based on the data available, it is unlikely that the wave climate it influenced by climate change forcings.

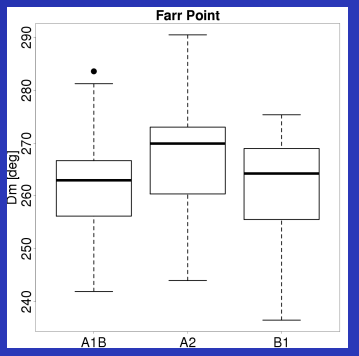












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Conclusions

- Over the 21st century, some changes in magnitudes can be observed in the wave climate projections for the three selected scenarios from the contemporary climate
- However, based on the data and methods used, it cannot be concluded that these are linked with atmospheric greenhouse gas concentrations
- It is possible that these may be a result of the natural variability of the system

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